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The National Aeronautics and Space Administration (NASA) is acquiring shuttle facilities to support the Space Transportation System. A review of the shuttle facility program focused on the current cost, schedule, and performance status. In late 1971, NASA established a \$300 million target to acquire the facilities needed. Through fiscal year 1977, Congress appropriated \$259 million in construction of facilities funds for 52 shuttle facilities. Of these, 13 are complete, and construction has started on 29 others. The remaining eight projects are scheduled to begin construction in calendar year 1977. Congress also approved \$21.5 million in research and development funds for major engine test and assembly facilities at Santa Susana and Canoga Park, California.

Findings/Conclusions: The NASA commitment to acquire the necessary facilities for \$300 million in 1971 dollars lacked some documentation and definition. Therefore, it could not be used as a baseline against which the progress of the shuttle facility program could be assessed. Based on NASA's current estimate of \$458.2 million, a net increase, including inflation, of \$48.2 million has occurred since the program's inception. The current estimate is not, however, completely supported by documentation, and does not include at least \$66.3 million for additional shuttle-related facility work. Recommendations: NASA should include the estimated cost of certain shuttle-related facilities in the current estimate and charge the costs against the commitment. The agency should identify and estimate separately costs for all shuttle-related facilities not considered to be covered by its commitment. (Author/DJM)

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REPORT TO THE CONGRESS

BY THE COMPTROLLER GENERAL
OF THE UNITED STATES

Space Shuttle Facility Program: More Definitive Cost Information Needed

National Aeronautics and Space Administration

This report discusses NASA's commitment to acquire shuttle facilities and the current status of the acquisition. The commitment and current estimates are not sufficiently supported by documentation, and the facilities NASA intended to include in its commitment cannot be accurately determined.

The Congress should require NASA to provide more definitive information from which the progress of NASA's major facility acquisition programs can be measured and assessed.



COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-183134

To the President of the Senate and the
Speaker of the House of Representatives

This is our report on the National Aeronautics and Space Administration's acquisition of facilities for the Space Transportation System which discusses the need for a commitment to be defined, documented, and understood clearly if it is to be used as a baseline to follow program changes and measure overall program progress.

We made our review as a part of our continuing effort to keep the Congress apprised of the status of major acquisitions and to assist it in exercising its legislative and review functions.

Our review was made pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53), and the Accounting and Auditing Act of 1950 (31 U.S.C. 67).

We are sending copies of this report to the Director, Office of Management and Budget, and to the Administrator, National Aeronautics and Space Administration.

A handwritten signature in dark ink, reading "James A. Stacks", is positioned above the title.

Comptroller General
of the United States

COMPTROLLER GENERAL'S
REPORT TO THE CONGRESS

SPACE SHUTTLE FACILITY
PROGRAM: MORE DEFINITIVE
COST INFORMATION NEEDED
National Aeronautics
and Space Administration

D I G E S T

In this report GAO shows why the Congress should require the National Aeronautics and Space Administration (NASA) to provide more definitive information from which progress on large facility acquisition programs can be measured and assessed. (See pp. 7 and 8.)

In March 1972 NASA made a commitment to the Congress to acquire facilities necessary to develop, test, and operate the space shuttle for \$300 million in 1971 dollars. A month later, NASA estimated that inflation would increase the cost to \$410 million.

This commitment lacked some documentation. Assumptions used to estimate costs were not detailed enough; GAO could not determine whether NASA intended certain shuttle-related facilities to be included in the commitment. These facilities would include those to assemble, integrate, and check out space shuttle payloads (satellites, space lab, upper stages). The commitment therefore cannot be used as a starting point to either follow program changes or measure overall program progress. (See pp. 4 to 8.)

In August 1976 NASA estimated that the facilities would cost \$458.2 million, including inflation, a \$48.2 million net increase over its first estimate. Other shuttle-related facilities--launch systems, low-cost projects, and payload facilities--estimated to cost \$45.5 million should also be part of NASA's estimate. (See pp. 10 to 18.)

By including the facilities identified above, NASA's most recent estimate in 1971 dollars would be increased to \$319.6 million and, including inflation, would be \$503.7 million. (See pp. 10, 11, and 17.)

To present the program more clearly during authorization and appropriation hearings, the NASA Administrator should

- include the estimated cost of certain shuttle-related facilities in the current estimate and charge the costs against the commitment (see pp. 17 and 18) and
- identify and estimate separately costs for all shuttle-related facilities which the agency does not consider to be covered by its commitment (see p. 18.)

AGENCY COMMENTS

NASA, in reviewing this report, disagreed with GAO's recommendations. Its major concern was that the shuttle-related facilities that GAO wants charged against the commitment were either (1) excluded by definition, (2) never intended to be a part of the commitment, or (3) included in other shuttle funding. Notwithstanding NASA's concerns, it is GAO's view that the items in question are (1) needed to make the structure useful and operable, (2) an inherent part of the facility, or (3) substantially affixed to the structure, and should be charged against NASA's commitment. NASA's comments, included as appendix I, are discussed in the body of the report as appropriate.

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ABBREVIATIONS

DOD	Department of Defense
GAO	General Accounting Office
KSC	Kennedy Space Center
NASA	National Aeronautics and Space Administration
STS	Space Transportation System

GLOSSARY

Real year dollars ----- Also known as current dollars, are always associated with the purchasing power of the dollar in the year that the expenditure will occur. When future costs are stated, the figures given are the actual amounts which will be paid, including inflation.

1971 dollars Means the purchasing power of the dollar with 1971 as the base year. Estimates are in the base year dollars when future costs are adjusted to exclude inflation so that they reflect the level of purchasing power in the base year.

1972 dollars Same as above but with 1972 as the base year.

CHAPTER 1

INTRODUCTION

This report discusses the results of our review of the facilities being acquired by the National Aeronautics and Space Administration (NASA) to support the Space Transportation System (STS). The STS is to provide a new space transportation capability that will reduce the cost of space operations and support a wide range of scientific, defense, and commercial uses. The STS will consist of a space shuttle, spacelab, and upper stages.

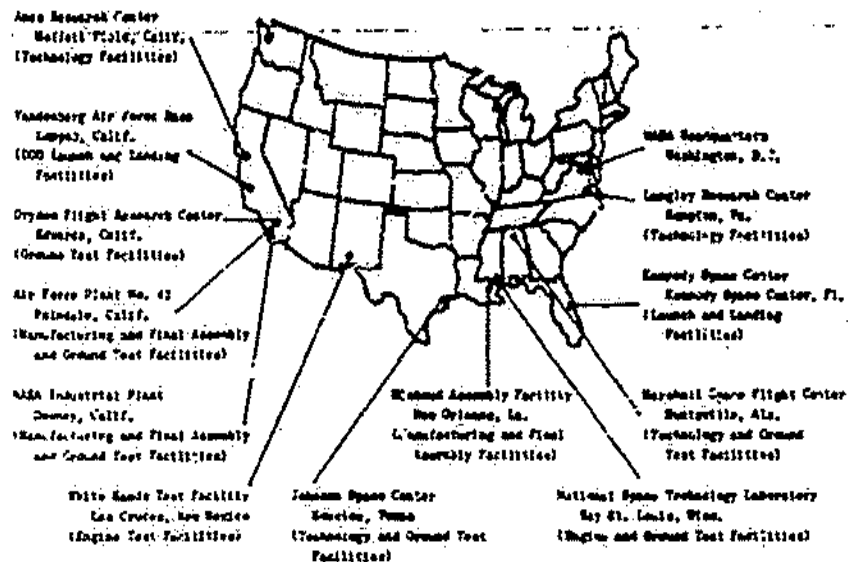
The space shuttle--comprised of a manned, reusable orbiter; an expendable, liquid propellant tank; and two reusable solid rocket boosters--will transport men, satellites, and other equipment into space. After completing a mission, the orbiter will return to Earth for refurbishment and reuse. The spacelab--being developed by the European Space Agency--is a laboratory and observatory for in-orbit space research. The upper stages are boosters which will be used to place satellites at altitudes higher than can be achieved by the orbiter alone.

PROGRAM DESCRIPTION

In the early space shuttle program definition studies, NASA identified the type and location of facilities required to support the development, test, and operation of the shuttle. This early study effort was directed toward maximizing the use of the multimillion dollar investment in the facilities NASA acquired for the Apollo program. Although new construction was necessary because of unique shuttle characteristics, NASA determined that many of the existing Apollo facilities could be modified or rearranged to support shuttle requirements.

Apollo facilities modified for the shuttle program include major ground test facilities, such as the dynamic test facility and engine test stands. NASA is also modifying major launch facilities, such as the vehicle assembly building, mobile launchers, and launch pads. New construction required includes an orbiter processing facility, a special payload facility, and a landing runway. (See app. II.)

Early cost estimates for these facilities were as high as \$600 million; subsequent refinements reduced the estimated cost to a range of \$300 million to \$400 million.



LOCATION OF MAJOR SHUTTLE FACILITIES

In late 1971 the NASA Administrator established a \$300 million target to acquire the facilities needed to develop, test, and operate the space shuttle. Through fiscal year 1977 the Congress appropriated \$259 million in construction of facilities funds for 52 shuttle facilities. Of these, 15 are complete and construction has started on 29 others. Construction on the remaining eight projects is scheduled to begin in calendar year 1977. The Congress also approved \$21.5 million in research and development funds for major engine test and assembly facilities at Santa Susana and Canoga Park, California.

MANAGEMENT RESPONSIBILITY

The Space Shuttle Program Director, NASA Headquarters, Washington, D.C., approves shuttle program facility requirements and schedules. The NASA Headquarters' Director of Facilities, with the concurrence of the Program Director, reviews and evaluates shuttle facility requirements received from NASA field centers, provides overall management and direction

of the facilities, and allocates funds to the field centers. In addition to determining requirements, field centers implement and manage the modification and construction work needed to support their assigned mission in the shuttle program.

REVIEW SCOPE

Our review was made at NASA Headquarters and at three of its field centers: Kennedy Space Center (KSC), Florida; Marshall Space Flight Center, Alabama; and Johnson Space Center, Texas. We examined the shuttle's facilities NASA is acquiring but did not review facilities which the Department of Defense (DOD) is to acquire for the launch and landing site at Vandenberg Air Force Base, California.

Our examination included a review of the shuttle facility program's current cost, schedule, and performance status. We also reviewed the basis for NASA's \$300 million commitment and its adequacy to complete the facility program. In conducting our review, we looked at documents, records, reports, and discussed the program with both headquarters and field center officials.

CHAPTER 2

FACILITY PROGRAM COST

COMMITMENT

NASA's commitment to the Congress to acquire space shuttle facilities at a cost of \$300 million in construction of facilities funds is not completely supported by documentation. In addition, some assumptions used to develop the estimate are not in sufficient detail to determine whether NASA intended that certain shuttle-related facilities would be included. As a result, the commitment can not be used as a baseline to track changes to the facility program or for determining where the overall program stands in relation to where it was expected to stand at any given point in time in terms of cost, schedule, and performance.

COMMITMENT DESCRIPTION

In March 1972 NASA made a commitment to the Congress that it would acquire facilities necessary to develop, test, and operate the space shuttle for \$300 million in 1971 dollars. Internal NASA estimates made a month later show that the facilities would cost \$410 million in real year dollars. To arrive at this estimate, NASA converted the \$300 million to real year dollars by using an 8-percent inflation rate, compounded annually, over a projected construction period of 1971 through 1979.

The commitment for shuttle facilities consists of eight functional categories plus facility planning and design effort as shown on the following page.

Space Shuttle Facility
Commitment

<u>Elements</u>	<u>Estimated cost</u> <u>in 1971 dollars</u>
	(millions)
Functional category:	
Technology	\$ 8.0
Engine test	20.1
Manufacturing and final assembly	12.0
Booster production and test	46.0
Vehicle development test	27.7
System integration and crew training	8.2
Mission control	5.0
Horizontal flight testing and launch and landing	<u>150.0</u>
	\$277.0
Planning and design	<u>23.0</u>
Total	<u>\$300.0</u>

In addition to the cost of the facility--normally referred to as the brick and mortar structure--the commitment includes the estimated cost of all collateral equipment. NASA defines collateral equipment to include equipment and property normally required to make the brick and mortar structure useful and operable. Collateral equipment includes electrical, pneumatic, control and monitor systems, and other equipment and property substantially affixed to the structure and considered to be an inherent part of the facility. The cost estimate also contains a 10-percent allowance for engineering services and a contingency ranging from 10 to 15 percent for each element.

The commitment does not provide for the purchase of ground support equipment, tooling, facility activation costs, and base support equipment. Ground support equipment and tooling are not included because they are not substantially affixed to the facility. Facility activation includes the costs of installing the ground support equipment and the integration and checkout of the facility systems with the ground support equipment. Base support equipment is not included because it represents multipurpose equipment, such as office and laboratory furniture, ground maintenance vehicles, ambulances, fire trucks, and mobile cranes.

Basic assumptions

NASA's commitment had to be based on several assumptions because the shuttle program was not completely defined at the time the commitment was made. Assumptions had to be made relative to the shuttle's configuration, program need dates for the facilities, use of existing facilities, and locations of the major facilities. Available information also shows that the commitment is to provide sufficient launch and landing facilities to achieve a shuttle launch rate of 40 flights a year at KSC. ^{1/} In addition, the commitment provides for the purchase of production facilities necessary to support a combined launch rate of 60 flights a year from KSC and Vandenberg.

These assumptions established the broad parameters of the shuttle facility program. Although the details and intent of some assumptions were not documented, available information shows that NASA intended the \$300 million commitment to provide for all facilities--including collateral equipment--needed to support "shuttle unique requirements." NASA advised the Congress that the commitment was to provide facilities needed to support the shuttle, but it did not define the term shuttle unique requirements. NASA's position is that certain shuttle-related facilities were never intended to be a part of the commitment, e.g., payload facilities estimated to cost \$28.1 million in real year dollars are not being charged against the commitment. (See pp. 13 to 16.)

SUPPORTING DOCUMENTATION

In support of its \$300 million commitment, NASA provided us a list of 58 facilities and estimated costs that comprise the 8 functional categories of shuttle facilities. NASA officials also provided various studies, preliminary engineering reports, and other documents which they said were considered in arriving at the commitment estimate. This data, however, does not show how the facility estimates were prepared, and does not support the individual estimates contained on the list.

^{1/}Facilities to support an additional launch rate of 20 flights a year at the Vandenberg launch site are to be provided by DOD.

Based on our examination of the documentation provided, we could identify only 34 of the 58 facilities which appeared to be the same as those shown on the list. For these facilities, however, the estimates contained in the documentation NASA provided agreed with only seven of the estimates contained on the list. Furthermore, the documentation provided referred to facilities not shown on the list.

We discussed this matter with NASA officials, and they said that (1) the documents provided to support the commitment were only one of many inputs NASA used to arrive at the \$300 million estimate and (2) records showing the extent that the documents were used were not available. They also said that NASA's primary objective was to obtain the most realistic cost estimate possible within a relatively short time frame and that discussions which affected the estimate were not documented. They agreed that it was not possible to directly relate the data contained in the documents provided for our review to the facilities and cost estimates contained on the list. NASA officials further emphasized that considerable individual and collective engineering judgment was used to arrive at the individual project estimates with the goal of arriving at a total figure to which a commitment could be made.

Program baseline

NASA officials neither consider nor use the facility list as a baseline to measure and assess the progress of the overall shuttle facility program. NASA officials told us that they recognized when the commitment was made that changes would be made to facilities shown on the list and that their commitment was for the total estimate and not individual facilities. They further said that any attempt on our part to use the document as an initial baseline would be time consuming and nonproductive. They also emphasized that none of the 58 facilities were considered to be officially approved by NASA management.

According to NASA officials, the agency does not consider a facility to be officially approved until it has been reviewed and included in the agency's budget request. After this has occurred, the officials stated that they could explain any subsequent changes to both the scope and estimated cost of a facility. For these reasons, NASA does not attempt to use the initial list to track facility program changes. To measure program status, NASA apparently adds the estimated costs of facilities it considers covered by the commitment, deflates the total estimate to

1971 dollars, and compares the results with the \$300 million commitment.

NASA, taking exception to our position that the \$300 million (1971 dollars) commitment should be used as a baseline to follow program changes and measure overall program progress stated:

"GAO examined NASA's procedures for determining status vis-a-vis the commitment, i.e., de-escalating actual and projected costs to 1971 dollars. GAO offered no criticism of this technique for measuring overall program progress. NASA believes this system of comparing current status to a constant base (\$ 1971) is a good measure of program progress."

NASA's technique for deescalating actual and projected costs to 1971 dollars is not in question. Our concern is that the resulting 1971 dollar figure is not an effective measurement of program progress. An effective progress measurement system must be capable of measuring progress on both a total program and an individual element basis. Unless this is done, there is no way to identify and track program changes, such as facility additions, deletions, or individual facility cost growth.

CONCLUSIONS

The commitment is not completely defined and documented; therefore, it cannot be used as a baseline to (1) identify and track changes that have occurred in the program since its inception or (2) determine where the overall shuttle facility program stands in relationship to where it was expected to stand at any given point in time in terms of cost, schedule, and performance. Of what use, then, is the \$300 million commitment?

Although NASA has frequently advised the Congress that shuttle facilities will be acquired within the \$300 million commitment, such a measurement, in our opinion, is of little or no value when NASA subjectively determines which facilities and modifications are or are not intended to be covered by the commitment. For any commitment to serve its intended purpose, all parties to the commitment must clearly understand its contents before the implementation phase begins.

RECOMMENDATION TO THE CONGRESS

To obtain maximum program visibility during all phases of an acquisition cycle, the Congress should require NASA to provide more definitive information from which the progress of NASA's future major facility acquisition programs can be measured and assessed. We believe that this is a highly desirable management practice on all major acquisition programs; it is even more critical on those for which NASA has made a commitment--such as shuttle facilities--if any meaningful measurement is to be made of program status in relation to a commitment.

CHAPTER 3

PROGRAM STATUS

NASA's August 1976 estimate of \$458.2 million for space shuttle facilities represents a \$48.2 million net increase in real year dollars over its initial estimate. The estimate, however, is not completely supported by documentation, and it does not include additional shuttle-related facility work NASA estimated will cost at least \$66.3 million. We believe that \$45.5 million of this cost should be included in the estimate and the estimate's contingency increased to cover a reasonable part of future field center requirements. NASA's current 1971 dollar estimate of \$296.3 million is understated by \$23.3 million which would increase it to \$319.6 million, or \$19.6 million over the \$300 million commitment. The commitment would be exceeded further if the contingency were increased.

NASA believes that all facilities will be completed in time to satisfy shuttle program need dates but is concerned over the availability of the first launch pad by the scheduled need date. We did not find any indication of technical problems with the potential to degrade any facility's operational usefulness.

COST

In arriving at the \$296.3 million figure, NASA converted its real year dollar estimate of \$458.2 million to 1971 dollars by applying deflation rates ranging from 8- to 12-percent. NASA did not prepare a separate estimate in 1971 dollars for each of its space shuttle facilities.

Although we did not evaluate the reasonableness of the deflation rates, we did verify that the computations were generally accurate. The following schedule shows a breakdown of the estimates. (See p. 5 for NASA's March 1972 estimate.)

Shuttle Facility Cost Estimates
(August 1976)

<u>Elements.</u>	<u>Estimated cost</u>	
	<u>Real year</u> <u>dollars</u>	<u>1971</u> <u>dollars</u>
	(millions)	
Technology	\$ 8.9	\$ 8.0
Engine test	15.8	14.2
Manufacturing and final assembly	51.7	35.5
Ground test	55.0	42.8
Launch and landing	217.3	135.7
Minor facility projects	8.0	4.5
Contingency	71.3	33.0
Planning and design	<u>30.2</u>	<u>22.6</u>
Total	<u>\$458.2</u>	<u>\$296.3</u>

The \$458.2 million estimate represents a net increase of \$48.2 million over NASA's April 1972 real year dollar estimate of \$410 million. It was not possible to determine the specific reasons for the net increase because NASA did not prepare an adequate initial baseline for the shuttle facility program. (See pp. 4 to 8.)

In its comments, NASA states that the:

" * * * commitment was in 1971 equivalent dollars for the very reason that neither NASA nor the Congress could forecast the downstream inflation rates. NASA's performance should not be evaluated on a basis of not having accurately projected inflation rates."

We did not question the accuracy of projected inflation rates. Our concern was with cost changes primarily related to other than projected inflation rates.

Our methodology for determining the reasons for cost changes was to review facility estimates of \$311.1 million which NASA included in its annual budget requests (FY 1971-77). The \$311.1 million estimate consists of the budget amounts requested plus future amounts to complete the facilities. The agency's August 1976 estimate for these facilities totals \$353.6 million, or a net real year dollar increase of \$42.5 million which NASA attributed to (1) schedule delays, (2) deletion and addition of facilities, (3) changes in technical work scope, (4) construction ..

problems, and (5) higher than anticipated inflation rates at certain locations.

To illustrate what is happening, NASA, in its fiscal year 1975 budget request, estimated that modifications to the launch complex at KSC would cost about \$103.6 million. In August 1976 NASA estimated that the work would cost \$142.4 million--a real year dollar increase of \$38.6 million comprised of a \$16.3 million contingency for a third mobile launcher, \$7.2 million for the addition of a sound suppression system at one of the launch pads, \$6.1 million for schedule milestone slippages, \$1.2 million for requirement changes to the payload changeout room, and \$7.8 million for other changes.

Validity of estimate

We could not verify the accuracy of the current \$458.2 million estimate because of incomplete documentation. For testing purposes, we selected facilities with a total estimated cost of \$47 million and attempted to verify the individual estimates to supporting documentation. Although considerable data--preliminary engineering reports, field center estimates, and other related information--were available relative to the individual projects, significant differences existed between the dollar estimates contained in the source documents and those contained in the estimate. Available records did not explain reasons for the differences.

NASA headquarters officials agreed that documentation is not available to support many of the individual estimates contained in the current estimate. They stated that the types of source documents mentioned above were considered in preparing the estimate but that changes were often made based on management judgment. They also said that no documentation was prepared showing the rationale for such changes but added that they might be able to reconstruct the basis for some of the changes; this they said, would be a time-consuming process.

In addition, the \$458.2 million and \$296.3 million estimates do not include additional shuttle-related facility work estimated to cost at least \$66.3 million or \$33 million, respectively. The following schedule contains a breakdown of these costs.

Additional Shuttle-Related Facilities

<u>Item</u>	<u>Estimated cost</u>	
	<u>Real-year</u> <u>dollars</u>	<u>1971</u> <u>dollars</u>
	(millions)	
Launch systems	\$14.4	\$ 9.1
Minor facility projects	3.0	2.1
Payload facilities	28.1	12.1
Field center projected requirements	20.8	9.7
Total	<u>\$66.3</u>	<u>\$33.0</u>

Launch systems

The launch systems will connect the mobile launch platforms and launch pads to the space shuttle in preparation for a launch. They are to be permanently affixed to the launch platforms and pads and are inherent and essential parts of these facilities. The nature and purpose of some of the launch systems are shown below:

- Orbiter tail service mast: provides propellants, gases, and power to the orbiter.
- Hold down support arms: hold and support the shuttle in a vertical position prior to launch.
- Cabin access arm: provides entry to and exit from the orbiter on the launch pad.
- Interstage hydrogen vent: provides hydrogen gas venting, valve control, and electrical connections to the external tank.

The estimated cost of the launch systems is not included in NASA's \$458.2 million estimate because NASA considers the work to be developmental in nature. NASA's November 1972 planning documents, however, show that the launch systems were to be acquired with construction of facilities funds, but in April 1973 NASA decided to use shuttle research and development funds.

According to NASA, the

" * * * delineation as to what equipment is collateral to a facility (CoF funded) and what is non-collateral (R&D funded) in some cases is not easily determined. NASA very carefully studied this matter and published a definition in this regard and coordinated it with appropriate Congressional Committee Staffs in late 1973. This definition has been used since that time as the basis to include and to exclude items from the CoF commitment according to their merits. Such decisions are certainly not subjective determinations. * * *

The late 1973 definition referred to by NASA does not, in our opinion, have a direct bearing on the situation. A document prepared nearly 2 years after the commitment was made does not necessarily show what NASA's intent was at the time the commitment was made. At that time the launch systems were to be funded with construction of facilities funds, and as such should have been included in the \$300 million commitment. In addition the launch systems are needed to make the structure useful and operable.

Minor facility projects

This work includes the construction of minor new facilities as well as rehabilitation and modification to existing facilities for use in the shuttle program. NASA's January 1976 estimate for the shuttle facility program included \$1.8 million for this effort. Our review work at three NASA field centers showed, however, that the costs for many minor facility projects were not included in the \$1.8 million estimate. NASA headquarters officials agreed that many of the minor facility projects had not been included and initiated a review to determine if corrective actions were warranted.

After review, NASA headquarters increased the \$1.8 million estimate to \$8.2 million and included this amount in the \$458.2 million current estimate. NASA officials agree with us that a number of other shuttle facility projects costing about \$3 million are still not included in its current estimate. These facilities, similar to the other minor facilities NASA did include in the \$300 million commitment, were purchased with shuttle research and development funds and charged to the space shuttle development costs.

Payload facilities

Facilities will be required to inspect, test, and check out space shuttle payloads such as satellites, upper stages, and spacelab. NASA estimates that the payload facilities will cost about \$28.1 million and will be funded from the construction of facilities appropriation. The estimated cost of these facilities, however, is not included in the \$458.2 million estimate because NASA does not consider the facilities to be covered by its \$300 million commitment.

NASA advised us that the commitment to acquire space shuttle facilities does not include and was never intended to include facilities for assembly, integration, and check out of shuttle payloads. Therefore, the \$28.1 million estimate for these facilities was not included in the current estimate. The assumptions NASA used in arriving at the commitment estimate were not in sufficient detail to permit a determination as to which facilities are or are not intended to be covered by the commitment. Available documentation shows, however, that the commitment is intended to provide for all facilities needed to support "shuttle unique requirements."

Since NASA did not define this term when the commitment was made, it is not possible at this point in the program to independently determine NASA's original intent, relative to either including or excluding payload facilities from the commitment or current estimate. Notwithstanding intent, however, we believe that the cost of facilities specifically needed to support a program, i.e., assemble, integrate, and check out shuttle payloads, should appropriately have been included.

Field center projected requirements

NASA's current estimate does not include at least \$20.8 million for shuttle facility requirements projected by NASA field centers. Examples of these requirements are (1) the addition of an automatic fire sprinkler protection system, (2) selected corridor rearrangements in the vehicle assembly building, (3) additional modifications to one of the launch pads, and (4) changes to external tank production facilities at the Michoud Assembly Facility, New Orleans, Louisiana.

Each year NASA field centers submit to headquarters their facility requirements, including space shuttle facilities, for the next 5-year period. NASA Headquarters

officials told us that they consider the centers' projected requirements in arriving at the best total estimate for shuttle facilities. They said, however, that the future facility requirements are not subjected to detailed technical and management reviews and, until such reviews are made, are considered primarily for planning purposes. Many of the centers' future requirements, therefore, are not included in the current estimate although NASA Headquarters may later validate some of them.

We analyzed the contingency included in the current estimate and found no provision for these future requirements. NASA Headquarters officials said that the provision for such a contingency would serve no useful purpose in the absence of appropriate technical and management reviews of the requirements.

SCHEDULE

The initial facility program milestones were based on the space shuttle achieving operational capability by 1979. NASA presently projects operational capability in May 1980. Because shuttle development has not progressed as planned, certain facilities were not needed as early as initially scheduled, and their milestone completion dates have been adjusted accordingly. Although some facility schedule milestone slippages have occurred for other reasons, the major changes have resulted from slippages in the shuttle development schedule.

In September 1976 NASA testified before the Subcommittee on Space Science and Application, House Committee on Science and Technology, that it was deeply concerned over the availability of the first launch pad by the scheduled need date. The launch pad modification work is currently 4 months behind schedule. In addition, modification work on the first mobile launcher is about 1 month behind schedule. NASA officials advised us that it is acting to make sure that all facilities will be complete by their need dates.

To meet schedules, KSC officials plan to compress and integrate certain installation and checkout work. If this can be successfully accomplished and if technical problems are not encountered during the remainder of the modification work, the two facilities should be ready for the first manned orbital flight.

PERFORMANCE

Although NASA has encountered construction and technical problems on shuttle facilities, we did not find any indication of technical problems with the potential to degrade the usefulness or intended purpose of the facilities. Several instances have occurred, however, where additional facility modifications were required above those initially planned in order to resolve problems associated with the shuttle. For example, changes were required to the external tank production facilities because of problems associated with the shuttle's thermal protection system, and a water injection system is being incorporated into the launch pad to suppress higher than anticipated noise levels during launch.

CONCLUSIONS

Based on NASA's current \$458.2 million estimate, a net increase of \$48.2 million has occurred since the inception of the facility program. The current estimate, however, is not completely supported by documentation and does not include at least \$66.3 million for additional shuttle-related facility work.

Of this amount, we believe that \$45.5 million--\$14.4 million for launch systems, \$3 million for minor facilities, and \$28.1 million for payload facilities--should be included in the current estimate. We also believe that the estimate's contingency should be increased to cover a reasonable part of the \$20.8 million in future facility requirements projected by NASA field centers.

In terms of 1971 dollars, we believe that NASA's estimate of \$296.3 million is understated by at least \$23.3 million and should be \$319.6 million--\$19.6 million over the \$300 million commitment. In addition, the commitment would be further exceeded if the above-mentioned contingency were increased.

RECOMMENDATIONS TO THE NASA ADMINISTRATOR

To provide better program visibility during the authorization and appropriation hearings, we recommend that the NASA Administrator:

- Include \$45.5 million and a reasonable contingency for future field center requirements in

its real year dollar estimate and charge an equivalent amount in 1971 dollars against the commitment.

--Provide a separate identification and related cost estimate for shuttle-related facilities, particularly field center projected requirements, which the agency does not consider to be covered by the commitment.



National Aeronautics and
Space Administration

Washington DC
20546

Regulatory Affairs W

February 16, 1977

Mr. Chester S. Daniels
Assistant Director
Procurement and Systems
Acquisition Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Daniels:

We appreciate the opportunity afforded NASA to comment on GAO's revised draft of the report entitled "Space Shuttle Facility Program: Commitment, Status, and Issues," as revised in your telephone conversation with me on February 14, 1977. We recognize that the discussions between NASA and GAO staff members have resulted in the resolution of a number of issues and in the clarification of the respective positions on other matters. In our attached remaining comments we do not agree with the recommendations of page 15 of the draft report, for the cited reasons.

Sincerely,

A handwritten signature in cursive script, appearing to read "John M. Coulter".

John M. Coulter
Acting Assistant Administrator for
DOD and Interagency Affairs

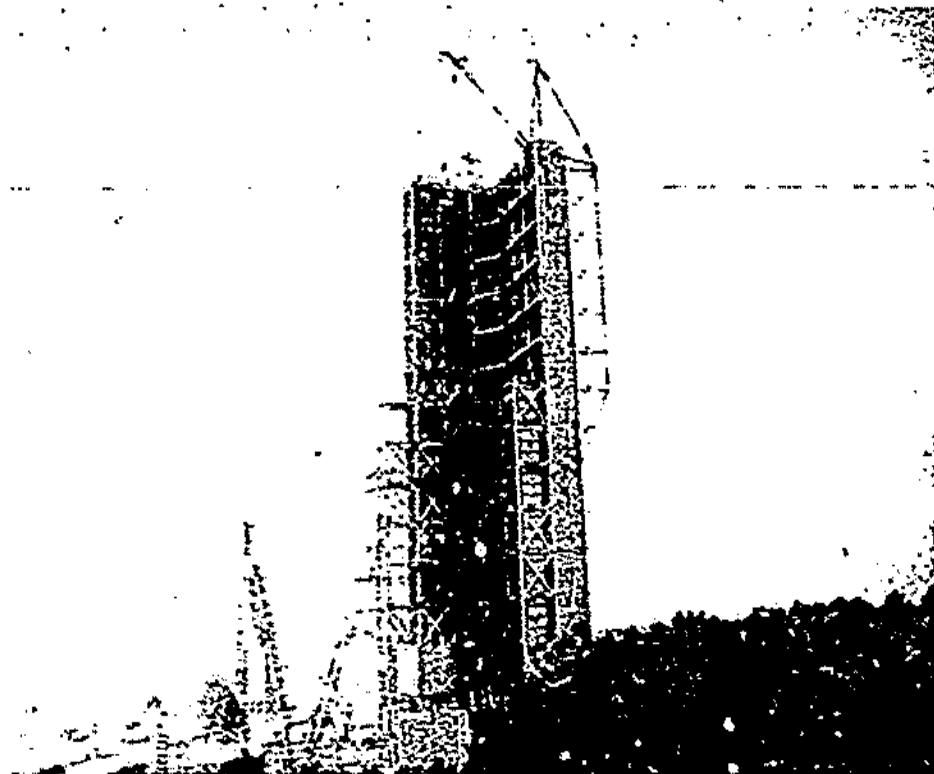
Enclosure

GAO note: Draft report title changed to Space Shuttle
Facility Program: More Definitive Cost
Information Needed.

NASA COMMENTS ON
GAO DRAFT REPORT "SPACE SHUTTLE
FACILITY PROGRAM: COMMITMENT,
STATUS AND ISSUES"

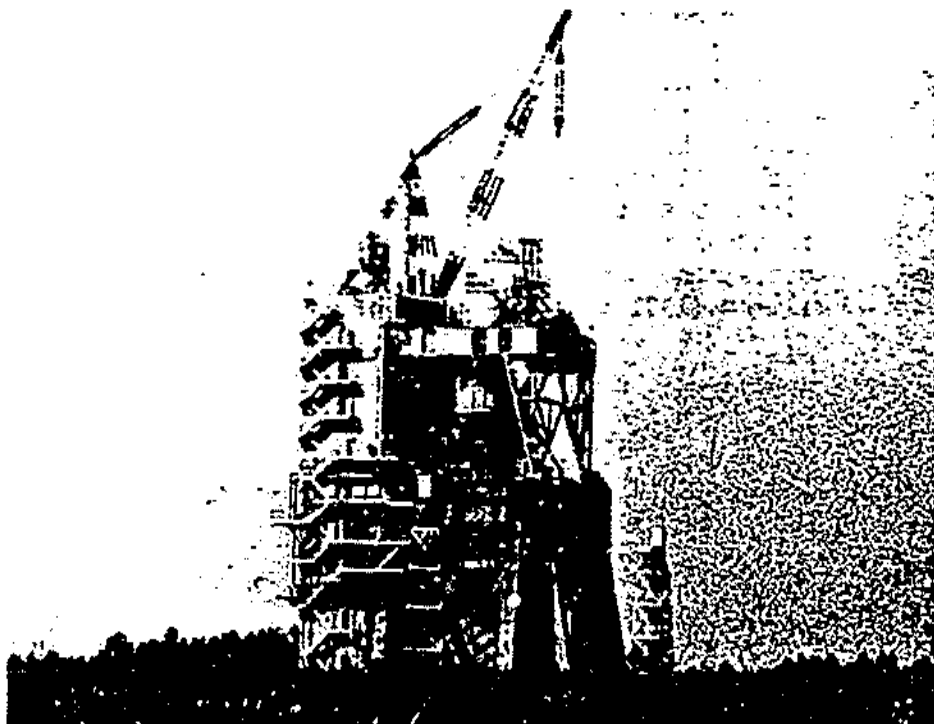
1. The \$300 million (1971 \$) shuttle facilities commitment cannot be used as a baseline to either follow program changes or measure overall program progress. NASA made a commitment to Congress to construct all shuttle unique facilities needed to achieve operational status within a total of \$300 million in Construction of Facilities funds in 1971 equivalent dollars. The commitment was to a TOTAL amount. GAO examined NASA's procedures for determining status vis-a-vis the commitment, i.e., de-escalating actual and projected costs to 1971 dollars. GAO offered no criticism of this technique for measuring overall program progress. NASA believes this system of comparing current status to a constant base (\$ 1971) is a good measure of program progress.
2. There has been a \$48.2 million increase in budget year dollars for the total construction program since NASA first published its assumptions on total costs at the time of the original commitment. The commitment was in 1971 equivalent dollars for the very reason that neither NASA nor the Congress could forecast the downstream inflation rates. NASA's performance should not be evaluated on a basis of not having accurately projected inflation rates.
3. NASA should charge the cost of launch systems, payload facilities and minor facility projects to the commitment. The NASA commitment is to provide CoF funded items needed to reach that shuttle operational flight rate. It does not include the items cited by the GAO as outlined below.
 - a. Launch Systems. The delineation as to what equipment is collateral to a facility (CoF funded) and what is non-collateral (R&D funded) in some cases is not easily determined. NASA very carefully studied this matter and published a definition in this regard and coordinated it with appropriate Congressional Committee Staffs in late 1973. This definition has been used since that time as the basis to include and to exclude items from the CoF commitment according to their merits. Such decisions are certainly not subjective determinations as charged in the report.

- b. Payload Facilities. It has always been accepted by all parties to the commitment that payload facilities, except for facilities at the launch complex used for insertion and removal of payloads from the orbiter, are outside the \$300 million commitment. This separation is in keeping with the programmatic separation of payloads development and operations from the shuttle development and operations, and is borne out by the FY 1977 NASA budget as enacted by the Congress which allocated payloads facility funds separately from shuttle facility funds.
- c. Minor Facility Work. The GAO report states that there is approximately \$3 million in R&D funded facilities projects which have not been charged to the \$300 million CoF commitment. This is correct. The annual NASA Authorization Act provides for accomplishing smaller facility work projects with R&D funds. The projects are usually of a short response, plant rearrangement, or direct hardware support nature. The projects accomplished under this authority which have made use of shuttle R&D funds have been charged to the \$5.2 billion R&D shuttle commitment. In addition to the shuttle R&D funded projects, certain Center Directors, using their authority, have accomplished minor projects with other than CoF or shuttle R&D funds. These projects have been carefully reviewed and those which meet the shuttle unique definition are maintained in a separate listing. When these projects are added to the Shuttle facilities CoF "runout" totals, the combined total is well within the \$300 million (1971 \$) CoF commitment.



NASA PHOTO

DYNAMIC TEST FACILITY



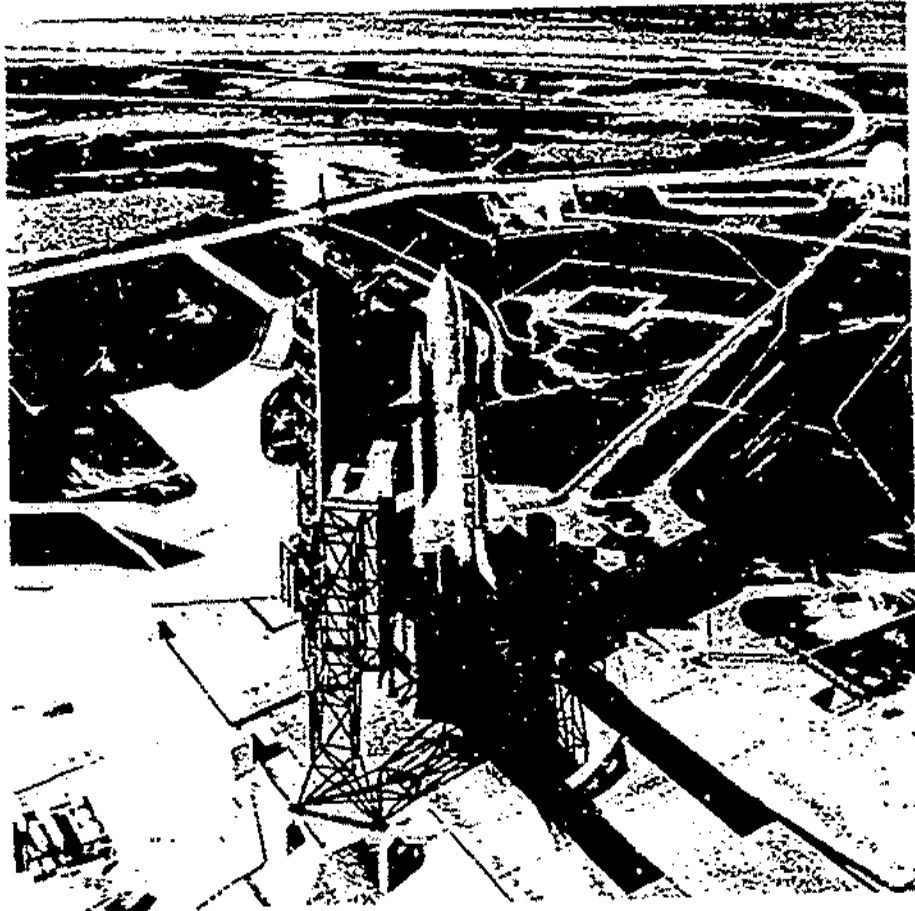
NASA PHOTO

ENGINE TEST STANDS



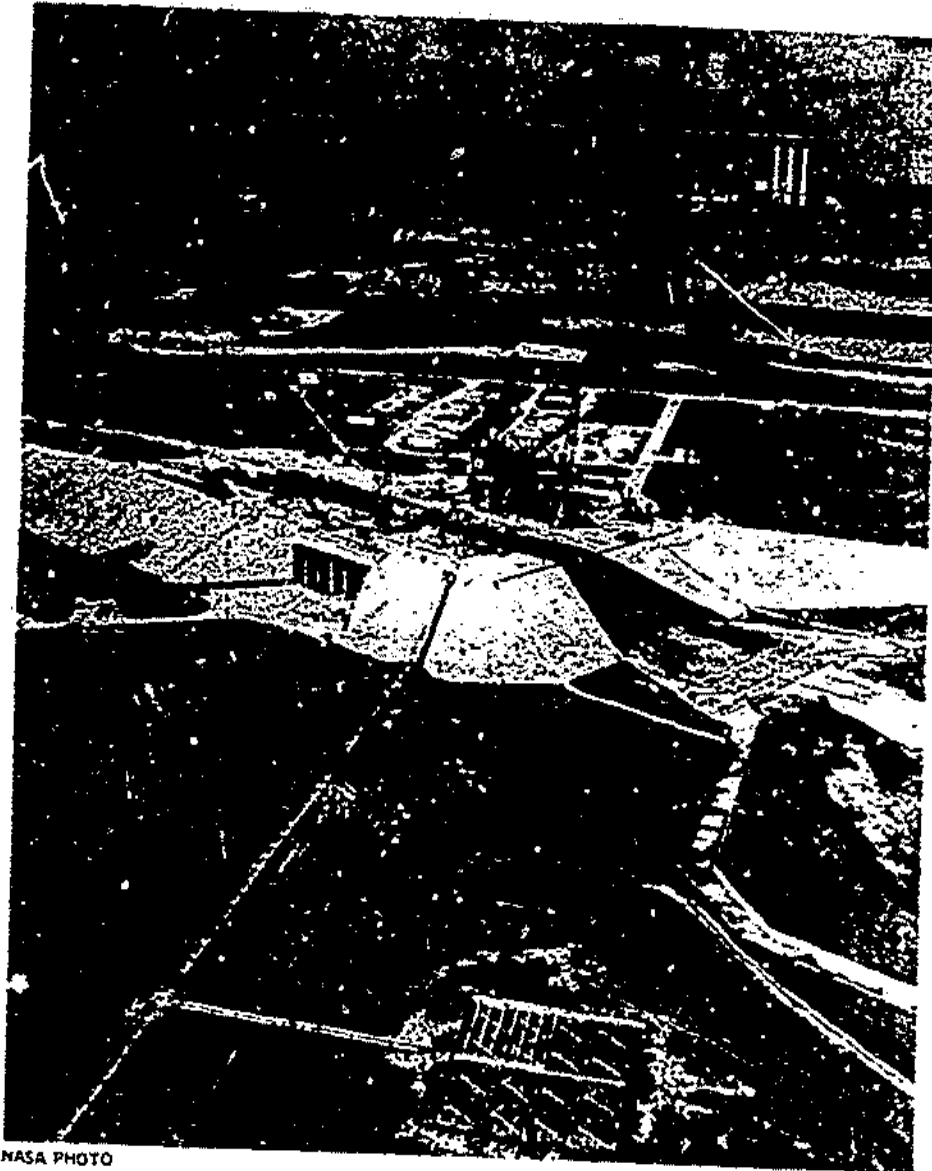
NASA PHOTO

VEHICLE ASSEMBLY BUILDING
WITH LAUNCH PADS IN THE BACKGROUND



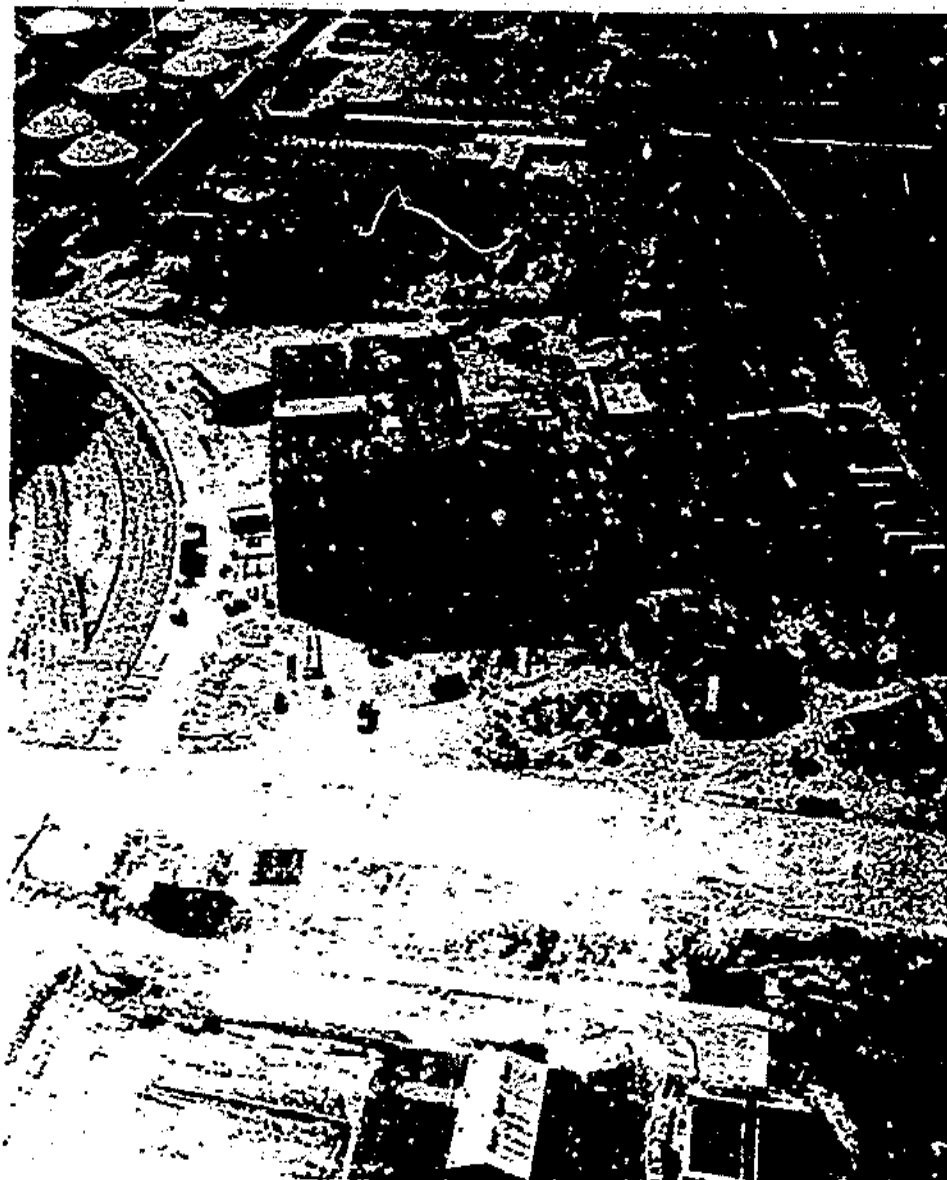
NASA PHOTO

ARTIST'S CONCEPT OF THE SPACE SHUTTLE
AND MOBILE LAUNCHER ON THE PAD



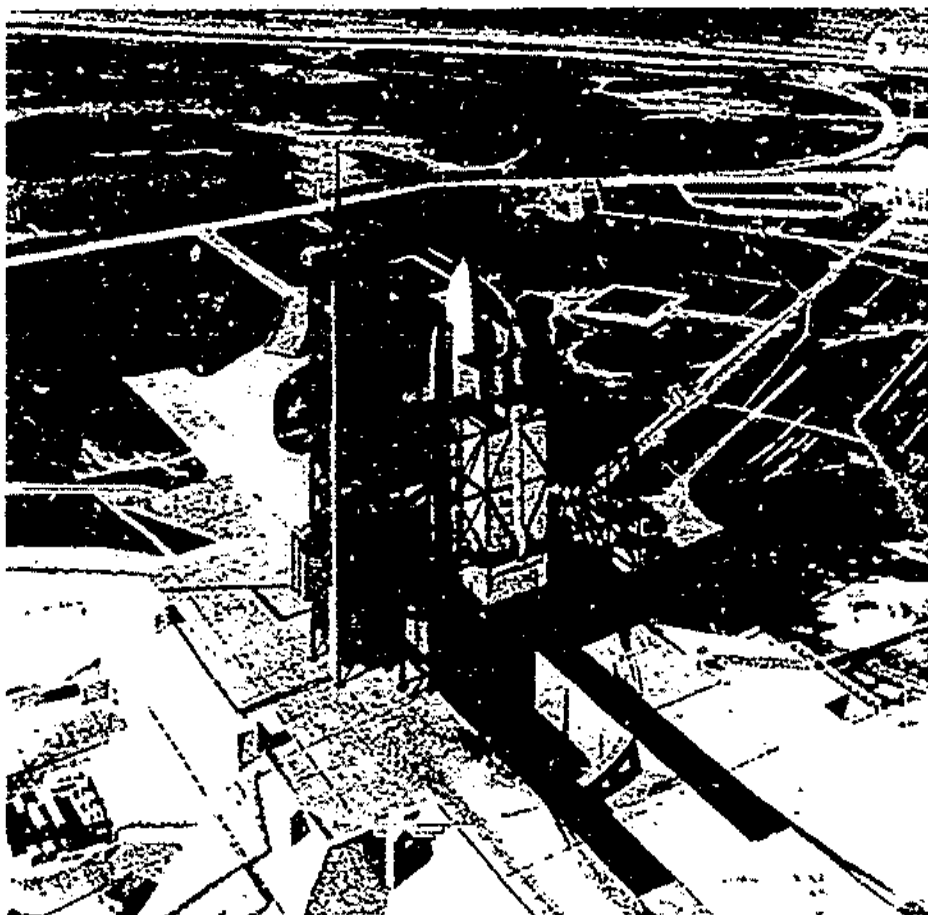
NASA PHOTO

LAUNCH PAD UNDER MODIFICATION



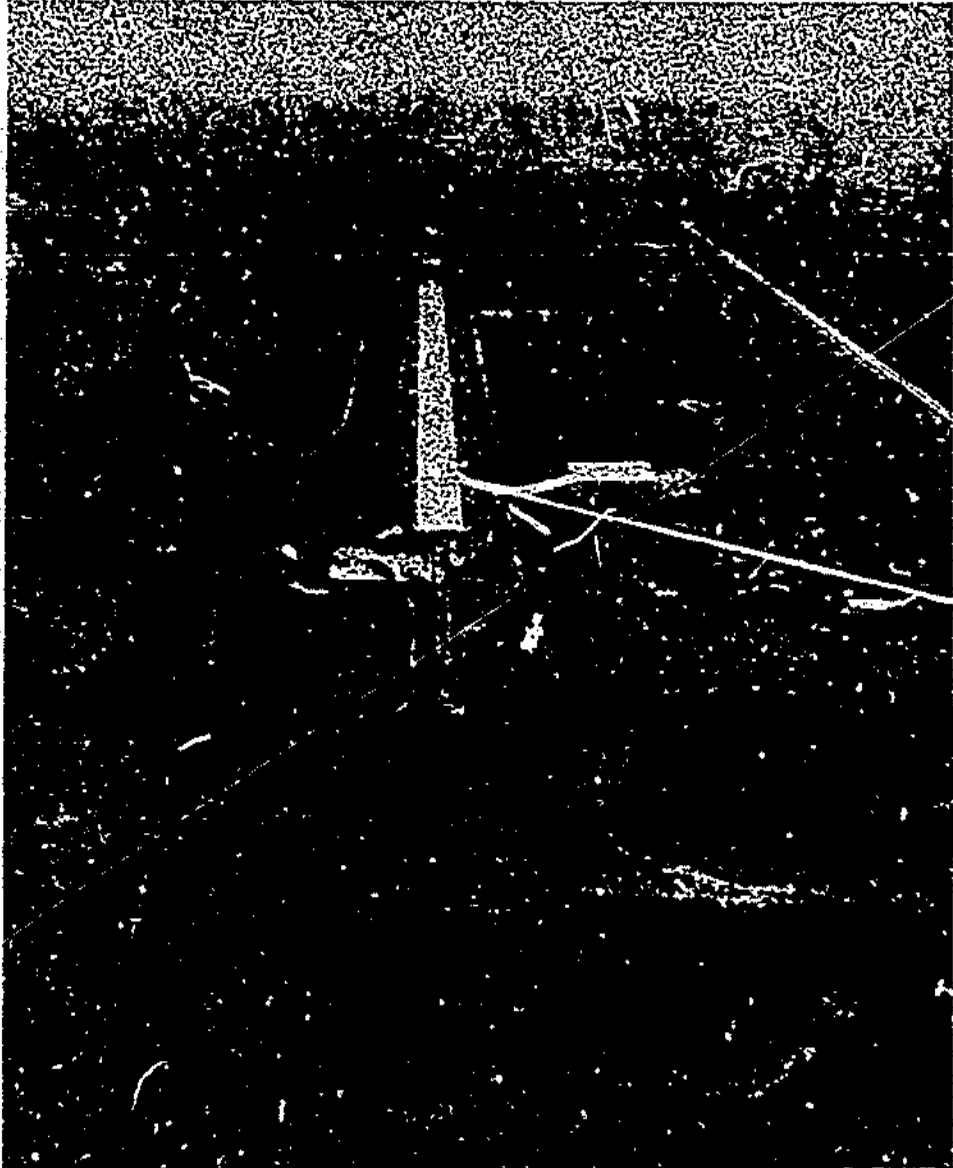
NASA PHOTO

ORBITER PROCESSING FACILITY UNDER CONSTRUCTION



NASA PHOTO

ARTIST'S CONCEPT OF THE SPACE SHUTTLE ON THE PAD
WITH PAYLOAD CHANGEOUT ROOM IN POSITION



NASA PHOTO

ORBITER LANDING FACILITY

PRINCIPAL OFFICIALS OF THE
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
RESPONSIBLE FOR THE ACTIVITIES DISCUSSED IN THIS REPORT

	<u>Tenure of office</u>	
	<u>From</u>	<u>To</u>
ADMINISTRATOR:		
Alan M. Lovelace (acting)	May 1977	Present
James C. Fletcher	Apr. 1971	May 1977
George M. Low (acting)	Sept. 1970	Apr. 1971
DEPUTY ADMINISTRATOR:		
Alan M. Lovelace	June 1976	Present
George M. Low	Dec. 1969	June 1976
ASSOCIATE ADMINISTRATOR:		
John E. Naugle	May 1975	Present
Rocco A. Petrone	Mar. 1974	Apr. 1975
Homer E. Newell	Oct. 1967	Mar. 1974
ASSOCIATE DEPUTY ADMINISTRATOR:		
Willis H. Shapely	Sept. 1965	Present
ASSOCIATE ADMINISTRATOR FOR CENTER OPERATIONS:		
Elmer S. Groo	Sept. 1974	Present
George M. Low (acting)	Mar. 1974	Sept. 1974
COMPTROLLER:		
William E. Lilly (note a)	Feb. 1967	Present
DIRECTOR OF FACILITIES:		
Robert H. Curtin	May 1968	Present

a/Position established in December 1972. Before that date the Comptroller function was part of the Office of the Associate Administrator for Organization and Management.